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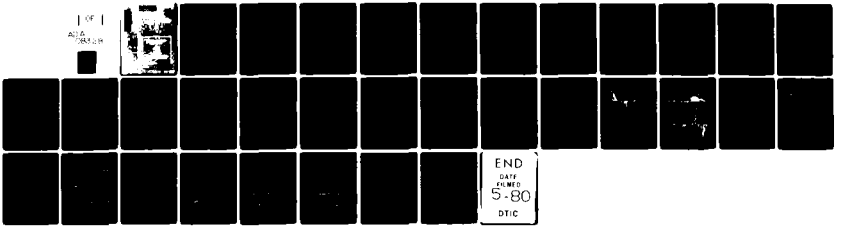

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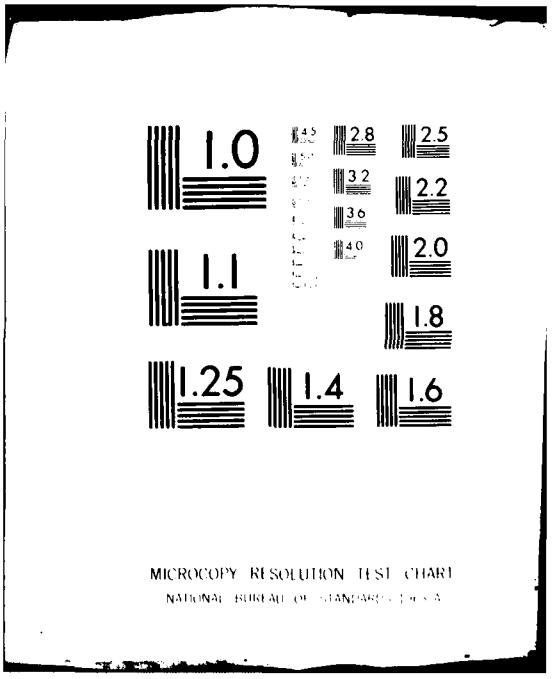
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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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2. Currents
3. Temperature

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Current and temperature measurements from instruments on moorings set in 1973 at Site D and the Muir Seamount are presented. Both horizontal and vertical arrays are presented using low-passed filtered data. The basic time series from individual current meters are displayed with statistical tables, spectral diagrams, progressive vector plots, and plots of variables versus time.

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WHOI-79-87

A COMPILATION OF MOORED CURRENT METER DATA AND ASSOCIATED OCEANOGRAPHIC OBSERVATIONS, VOLUME XXII (1973 OBSERVATIONS)

by

Susan Tarbell
and Richard Payne

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

December 1979

TECHNICAL REPORT

Prepared for the Office of Naval Research under Contract N00014-76-C-0197, NR 083-400.

Approved for Distribution:

Valentine Worthington, Chairman
Department of Physical Oceanography

ABSTRACT

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5181	3/ A /7
5182	3/ B /7
5191	3/ C /7
5192	3/ D /7
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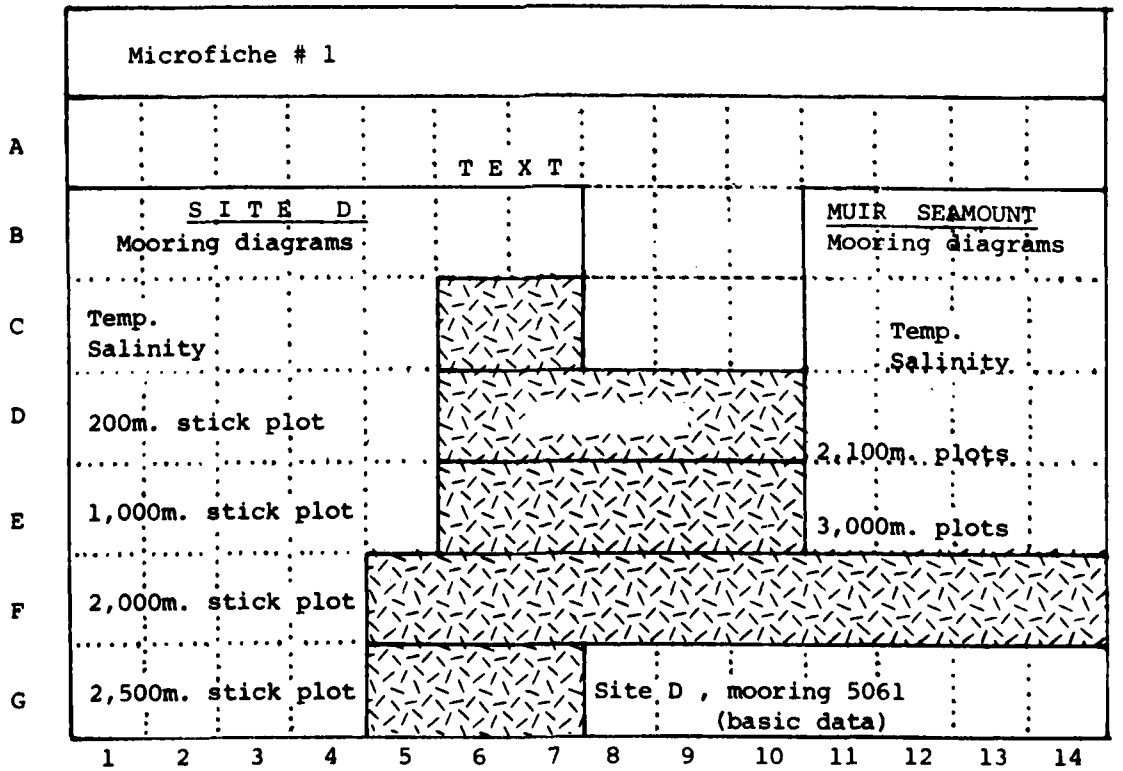

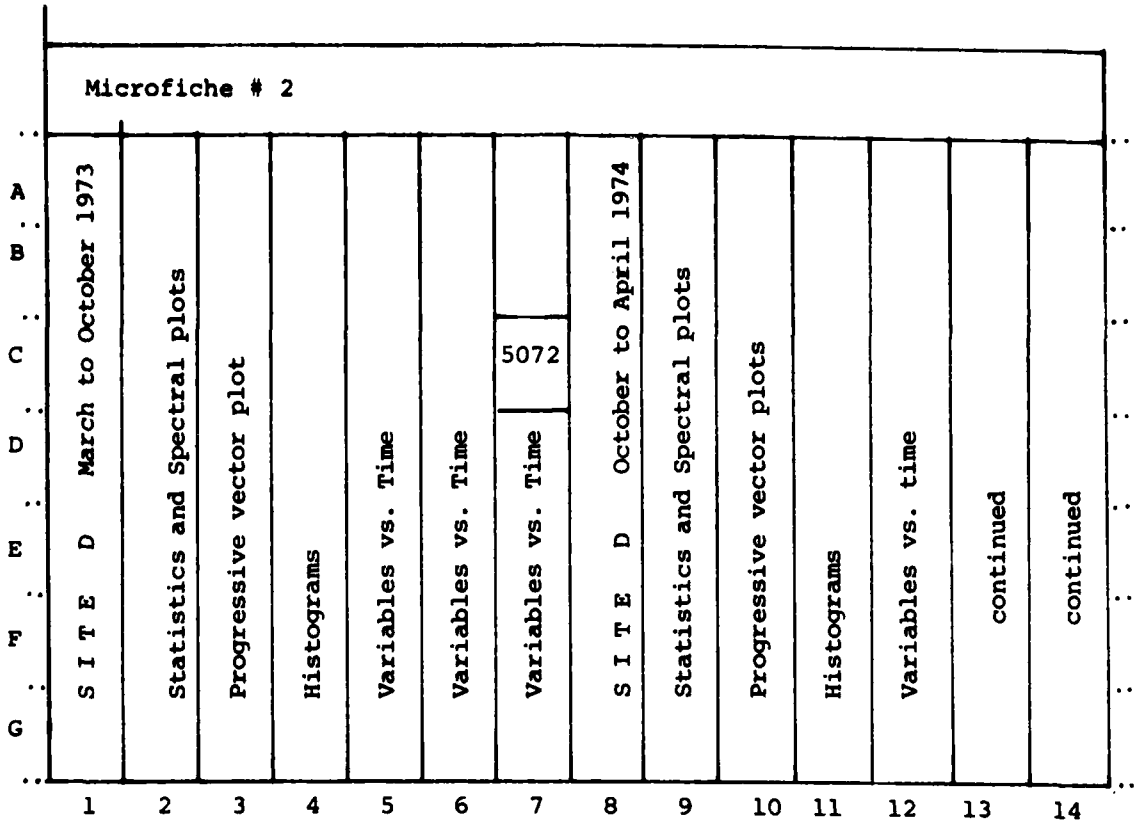
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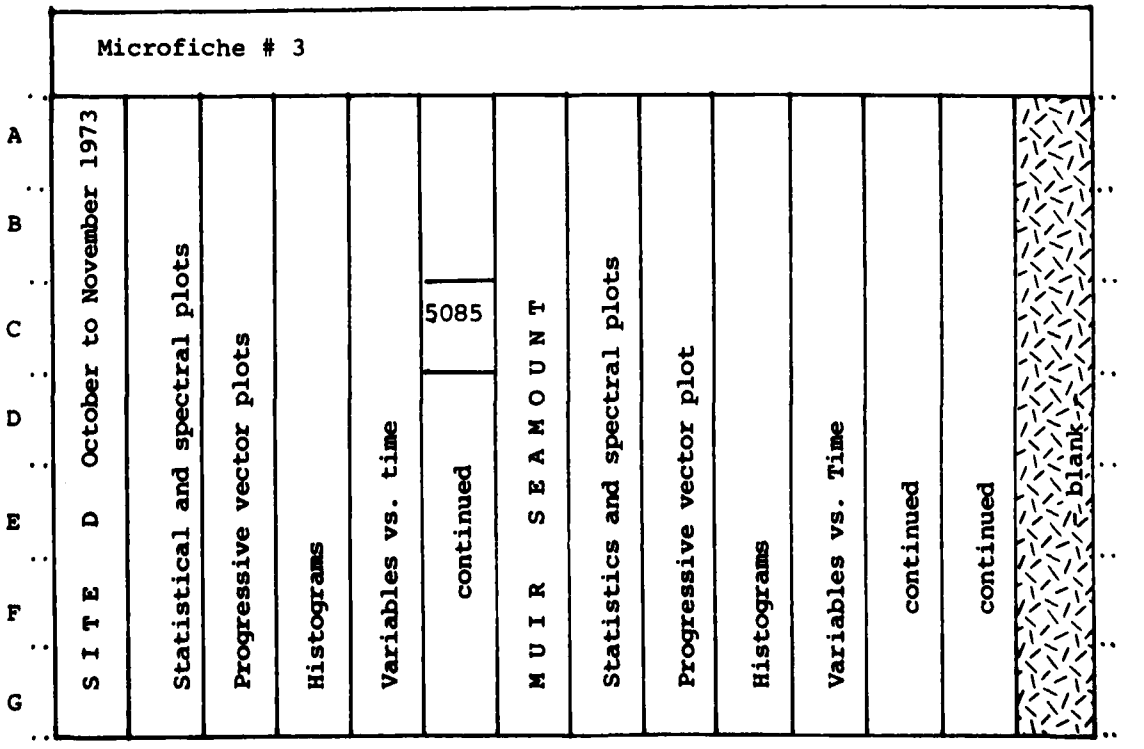
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Acknowledgments

Credit for attacking and solving the problems which inevitably crop up in a new instrument, in this case the VACM, should go to J. Dean and the Buoy Group Instrument Shop personnel. David Simoneau and Mooring Shop personnel did their usual excellent job of fabricating, deploying, and retrieving the moorings with the usual excellent support of the WHOI ships' crews.

PREFACE

This volume is the twenty-second in a series of WHOI Technical Reports presenting moored current meter data collected by the WHOI Buoy Group.

Volume XXII presents data from moorings set during 1973 and completes the data presentation for that year.

Volume Number	Ref. #	Authors	Year, Experiments Notes
I	65-44	Webster, F. and N. P. Fofonoff	
II	66-60	Webster, F. and N. P. Fofonoff	
III	67-66	Webster, F. and N. P. Fofonoff	
IV	70-40	Pollard, R. T.	1965 Measurements
V	71-50	Tarbell, S. and F. Webster	1966 Measurements
VI	74-4	Tarbell, S.	1967 Measurements
VII	74-52	Chausse, D. and S. Tarbell	1968 Measurements
VIII	75-7	Pollard, R. T. and S. Tarbell	1970 Array Data
IX	75-68	Tarbell, S., M.G. Briscoe and D. Chausse	1973 IWEX Array
X	76-40	Tarbell, S.	1969A Measurements
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XIII	77-18	Tarbell, S. and A. W. Whitlatch	1970 Measurements
XIV	77-41	Tarbell, S., R. Payne and R. Walden	1976 St. Croix Mooring
XV	77-56	Tarbell, S. and A. W. Whitlatch	1971 Measurements
XVI	78-5	Tarbell, S. and A. Spencer	1971-1975 MODE Site
XVII	78-49	Tarbell, S., A. Spencer and R. Payne	POLYMODE Array II
XVIII	78-93	Tarbell, S., M.G. Briscoe and R.A. Weller	1978 JASIN
XIX	79-34	Spencer, A., C. Mills and R. Payne	1974-1975 POLYMODE Array
XX	79-56	Spencer, A.	1974-1975 Rise Array
XXI	79-85	Mills, C. and P. Rhines	1978 W.B.U.C.

INTRODUCTION

The data presented in this report are the results of three separate experiments which took place in 1973:

A. A continuation of the long time series at Site D (see Preface; Volumes I-VIII, X, XI, XIII, and XV contain earlier data from this site).

B. A current meter comparison at Site D.

C. Three moorings set in the vicinity of the Muir Seamount.

Figure 1 shows the locations of Site D and the Muir Seamount and the relative mooring locations.

With this report we continue our presentations of the Site D mooring series which began in 1965 and continued for 10 years with only a few gaps.

On mooring 508, also at Site D, were placed nine VACMs and one Model 850 spaced at four meter intervals from 2649 m to 2685 m depth, the 850 at the bottom. The purpose of this mooring was to test a number of modifications to the original instrument, mainly in bearings and electronics.

The Muir Seamount experiment was designed by Professor Carl Wunsch of M.I.T. to examine the oceanic variability near the Seamount to test the hypothesis that diurnal period waves would be found trapped, forced by the barotropic diurnal tide. Evidence for the trapped waves was indeed found. Some of the observations and a simple analytical model which provides an approach to the dynamics of such waves may be found in Hendry (1975). See also Wunsch (1975, 1976).

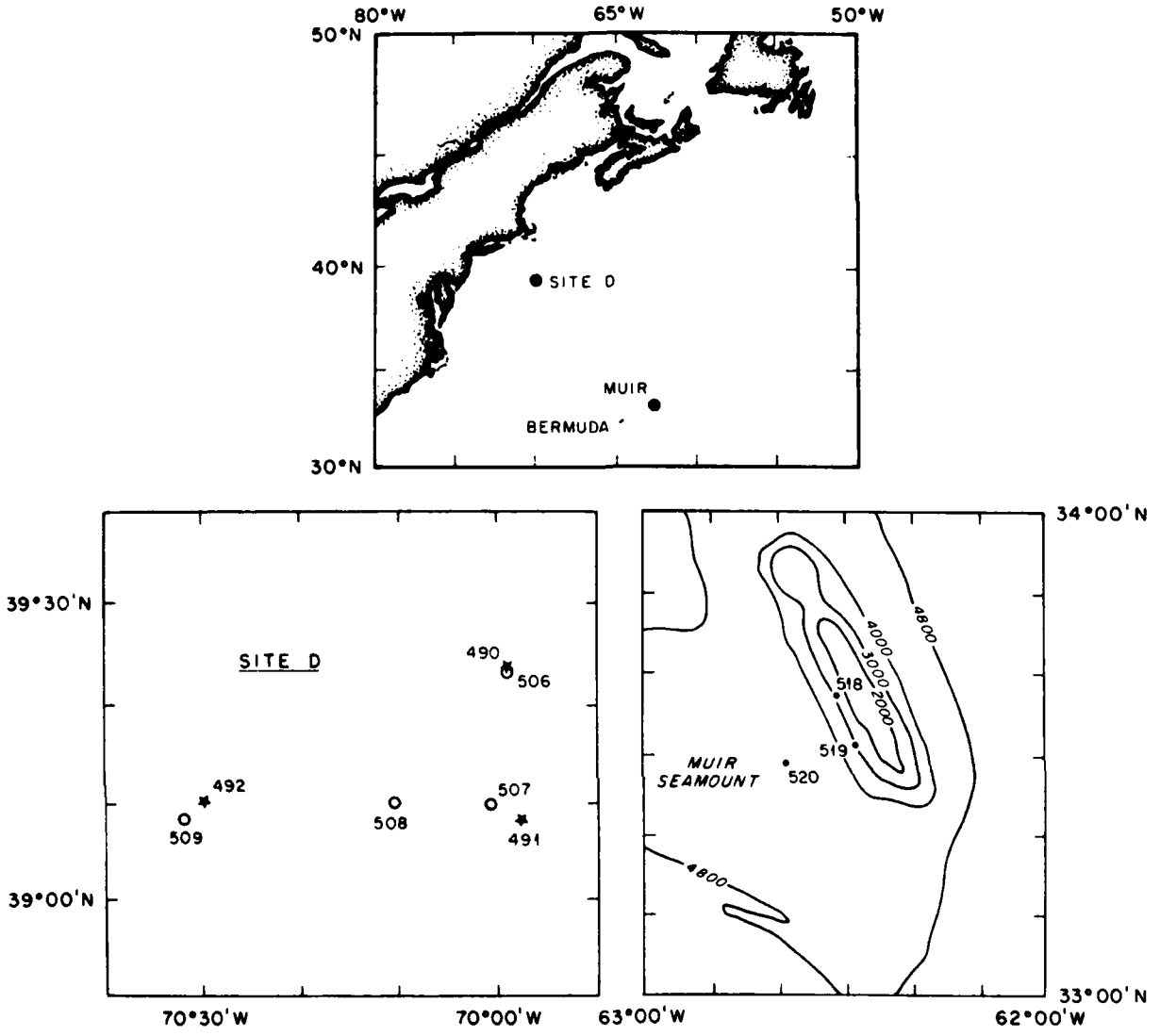

Figure 1. The upper chart shows where moorings were set in the North Western Atlantic in 1973. The Site D chart (lower left) uses the following key:

* Mooring set March to October 1963

○ Mooring set October to April 1974

● Mooring set October, December 1963

The Muir Seamount chart (lower right) indicates mooring position relative to the bottom topography.

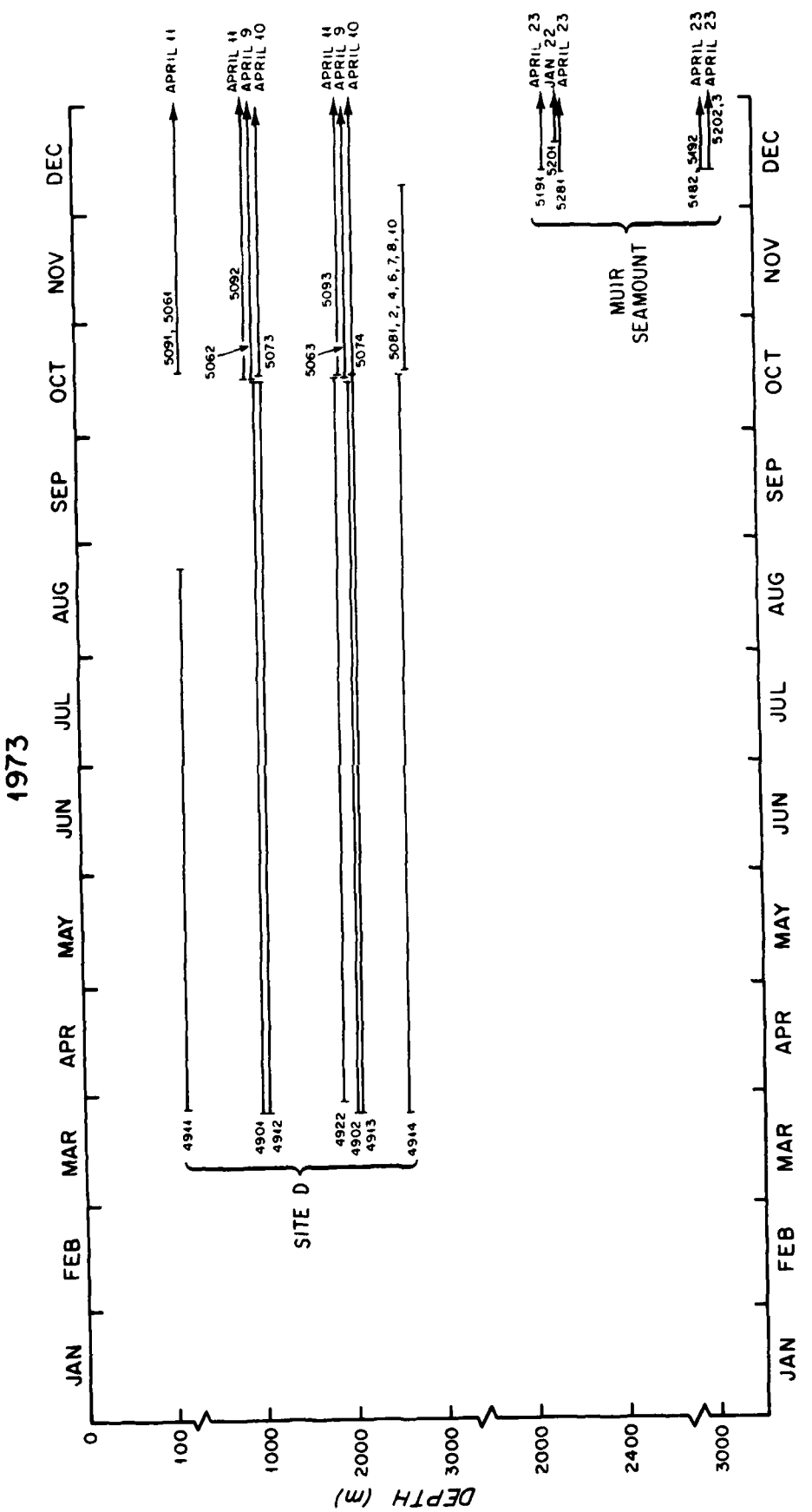

Figure 2. The time series presented in this report

Moorings Set in 1973

There were 43 moorings set in 1973. Twenty-one of the moorings were set as part of the Mid-Ocean Dynamics Experiment (MODE) and are described in WHOI Reference 76-101. Seven moorings were set for the Internal Wave Experiment (IWEX) and are included in WHOI Reference 75-68. Two moorings were set in the Windward Passage and are described in WHOI Reference 77-29. Our first 1 year mooring is described in WHOI Reference 79-56. Two moorings aborted during launch leaving ten moorings to be included in this report. Seven of the ten moorings are at Site D (39°20.0'N, 70°00.0'W) and three were set near the Muir Seamount (33°N, 62°W). Sur = Surface Mooring; Int = Intermediate Mooring; Btm = Bottom Mooring.

Table 1

Moor.	Latitude Longitude	Set Date Retrieval	Num. CM,TP	Dur-ation	Depth m	Comments
480 Sur	28°03.8'N 69°39.0'W	Mar. 10 1973 --- -- ----	-, -	Lost	5412	Surface mooring Believed stolen
481 Int	27°59.8'N 69°39.0'W	Mar. 10 1973 Jul. 4 1973	8,11	116	5462	MODE-1 WHOI Ref. 76-101
482	28°09.3'N 68°39.3'W	Mar. 12 1973 Jun. 26 1973	6, 2	106	5239	MODE-1 WHOI Ref. 76-101
483 Int	29°02.3'N 68°13.8'W	Mar. 12 1973 Mar. 12 1973	5, 3	113	5192	MODE-1 WHOI Ref. 76-101
484 Int	27°25.1'N 67°59.5'W	Mar. 13 1973 Jul. 3 1973	5, 2	112	5151	MODE-1 WHOI Ref. 76-101
485 Int	26°23.8'N 69°21.0'W	Mar. 13 1973 Jul. 2 1973	5, 8	111	5420	MODE-1 WHOI Ref. 76-101
486 Int	26°57.5'N 71°02.6'W	Mar. 14 1973 Jul. 2 1973	5, 2	110	5474	MODE-1 WHOI Ref. 76-101
487	-- -- -- -- -- --	Mar. 15 1973 Mar. 15 1973		0	----	Aborted during launch Line parted below release
488 Int	28°33.1'N 71°22.9'W	Mar. 15 1973 Jul. 1 1973	5, 2	108	5325	MODE-1 WHOI Ref. 76-101
489 Int	29°35.0'N 69°59.1'W	Mar. 16 1973 Jun. 30 1973	5, 2	106	5440	MODE-1 WHOI Ref. 76-101
490 Int	39°23.7'N 69°59.3'W	Mar. 26 1973 Oct. 15 1973	2, -	203	2559	Site D
491 Int	39°07.2'N 69°58.0'W	Mar. 26 1973 Oct. 16 1973	4, -	204	2654	Site D

x

Table 1 (cont.)

Moor.	Latitude Longitude	Set Date Retrieval	Num. CM,TP	Dur-ation	Depth m	Comments
492 Int	39°10.0'N 70°30.4'W	Mar. 29 1973 Oct. 16 1973	2, -	201	2794	Site D
493 Int	28°42.0'N 70°15.8'W	Mar. 31 1973 Jun. 30 1973	5, 3	91	5446	MODE-1 WHOI Ref. 76-101
494 Int	27°49.8'N 70°39.8'W	Apr. 1 1973 Jun. 29 1973	5, 3	89	5446	MODE-1 WHOI Ref. 76-101
495 Int	27°08.8'N 70°00.0'W	Apr. 1 1973 Jun. 29 1973	5, 3	89	5447	MODE-1 WHOI Ref. 76-101
496	-- -- -- -- -- --	Apr. 2 1973 Apr. 2 1973	-, -	0	----	Aborted during launch Line parted below release
497 Int	27° 18.0'N 69°01.0'W	Apr. 2 1973 Jun. 28 1973	6, 8	87	5296	MODE-1 WHOI Ref. 76-101
498 Int	27°33.1'N 69°34.1'W	Apr. 3 1973 Jun. 28 1973	4, 3	86	5463	MODE-1 WHOI Ref. 76-101
499 Int	28°08.9'N 70°08.1'W	Apr. 3 1973 Jun. 28 1973	4, 3	86	5461	MODE-1 WHOI Ref. 76-101
500 Int	28°17.0'N 69°16.3'W	Apr. 4 1973 Jun. 27 1973	4, 3	84	5456	MODE-1 WHOI Ref. 76-101
501 Int	28°50.1'N 69°18.0'W	Apr. 4 1973 Jun. 30 1973	6, 2	87	5379	MODE-1 WHOI Ref. 76-101
502 Int	28°08.9'N 68°41.4'W	Apr. 26 1973 Dec. 13 1973	3, -	231	5255	MODE WHOI Ref. 78-5
503 Int	28°00.2'N 69°44.4'W	Apr. 27 1973 Dec. 14 1973	3, -	231	5461	MODE WHOI Ref. 78-5
504 Int	20°18.0'N 73°38.0'W	Nov. 10 1973 Mar. 2 1974	2, 3	112	1539	WHOI Ref. 77-29
505 Int	20°17.0'N 73°38.0'W	Nov. 10 1973 Mar. 2 1973	2, 3	112	1543	WHOI Ref. 77-29
506 Int	39°23.2'N 69°59.6'W	Oct. 15 1973 Apr. 9 1974	3, -	176	2559	Site D
507 Int	39°09.8'N 70°00.8'W	Oct. 16 1973 Apr. 10 1974	5, -	176	2662	Site D
508 Int	39°09.8'N 70°10.9'W	Oct. 16 1973 Dec. 7 1973	10, -	52	2714	Site D VACM comparison
509 Int	39°08.5'N 70°32.4'W	Oct. 17 1973 Apr. 11 1974	3, -	176	2746	Site D
510 Sur	27°44.1'N 69°47.7'W	Oct. 27 1973 Dec. 16 1973	-, -	51	5459	IWEX WHOI Ref. 75-68

Table 1 (cont.)

Moor.	Latitude Longitude	Set Date Retrieval	Num. CM,TP	Dur-ation	Depth m	Comments
511 Sur	27°48.1'N 69°51.0'W	Oct. 26 1973 --- --- ---	-, -	Lost	5461	IWEX WHOI Ref. 75-68
512 Btm	27°43.9'N 69°49.0'W	Oct. 27 1973 Nov. 4 1973	-, -	8	5455	IWEX WHOI Ref. 75-68
513 Btm	27°45.4'N 69°52.0'W	Oct. 27 1973 Nov. 4 1973	-, -	8	5455	IWEX WHOI Ref. 75-68
514 Btm	27°42.4'N 69°52.0'W	Oct. 27 1973 Nov. 4 1973	-, -	8	5455	IWEX WHOI Ref. 75-68
515 Tri-moor	27°43.9'N 69°50.9'W	Nov. 1 1973 Dec. 16 1973	-, -	42	5455	IWEX WHOI Ref. 75-68
516 Sur	27°44.0'N 69°48.0'W	Nov. 3 1973 Nov. 5 1973	4, -	1	----	IWEX WHOI Ref. 75-68
517 Int	39°11.8'N 70°00.0'W	Dec. 7 1973 Dec. 5 1974	2, -	363	2647	Site D WHOI Ref. 79-56
518 Int	33°35.0'N 62°29.3'W	Dec. 10 1973 Apr. 23 1974	2, -	134	3138	Muir Seamount
519 Int	33°29.1'N 62°28.6'W	Dec. 10 1973 Apr. 23 1974	2, -	134	3088	Muir Seamount
520 Int	33°30.0'N 62°36.7'W	Dec. 11 1973 Apr. 23 1974	3, -	133	4366	Muir Seamount
521 Int	28°09.5'N 68°41.5'W	Dec. 13 1973 Apr. 20 1974	3, 9	128	5265	MODE WHOI Ref. 78-5
522 Int	28°00.5'N 69°44.8'W	Dec. 14 1973 Apr. 21 1974	3, 9	128	5462	MODE WHOI Ref. 78-5

FAKING BOX MOORING DEPLOYMENTS

Moorings 490 and 491 were set by a faking box technique. Ordinarily the Buoy Group's deployment technique is to gradually pay out mooring components while the ship steams slowly ahead. We start with the top flotation; the last thing over is the anchor. Deploying mooring 492, similar to 490 and 491, took about one hour by this technique. In the faking box technique, the entire mooring, line, flotation, instruments and all, was placed very carefully in specially designed wooden boxes at the rail. The anchor was kicked over which then pulled the rest of the mooring overboard, item by item, while the crew watched with mounting suspense. Deploying an entire mooring took about 10 minutes from anchor over to last item over. Although quick and successful in these two deployments concern arose over the possible damage which could be done to mooring components if something snagged and over the nervous condition of the spectators. The technique was retired after these two deployments.

INSTRUMENTATION

The instruments whose data are described are Vector Averaging Current Meters (VACM) and Model 850 current meters. They both use the same sensors, i.e., Savonius rotor, vane and internal compass to give speed and direction, but differ in their treatment of the data before recording. The VACM vector averages continually while the 850 burst samples once per recording interval.

The VACM records on Phillilps-type magnetic tape cassettes and the 850 on endless loop cartridges

The VACMs all record temperature using a thermistor embedded in the end cap. The conversion of the 850s to measure temperature had just begun in 1973, however, and only a few of the instruments had a similar arrangement.

DATA PROCESSING

The Phillips-type cassettes and endless-loop cartirdges were transcribed to 9-track computer compatible tapes, converted to scientific units, edited to remove launch and retrieval transients and bad data points, and linearly interpolated across missing or erroneous data cycles.

WHOI data are identified by a mooring number, a sequential instrument position number (e.g., 5074 is the fourth instrument down on mooring 507), a letter to indicate the data version (5074B is the second editing of 5074), and a number to indicate the recording interval for that data version (e.g., 5074B3600 is the one hour (3600 seconds) averaged version).

DATA PRESENTATION

The presentations in this report are time series, histograms, mean statistics, progressive vector plots and spectra. Additional details are below. The overall scheme is by experiment, chronologically by mooring, and by increasing depth. This report is presented on three sheets of microfiche with selected pages of the text and composite plots printed for easy reference. The first fiche contains text, composite plots of one day averaged data, mooring diagrams and temperature, salinity profiles. The second and third sheet display the basic data using the following programs (see diagrams of fiche layout, page iii, iv):

Time Series

Speed, direction, east and north components, and temperature, where recorded, are presented. Speed, direction and east, and north components are presented as analogue plots; low passed (Gaussian filter with 24 hour half width) versions of east and north subsampled once per day are presented as "stick" plots.

Histograms

Each variable is plotted as frequency of occurrence versus variable magnitude. The mean value is marked on the horizontal axis; on the histogram of the north component of the current, read $\overline{4}$, $\overline{5}$ as $\overline{N}$.

Mean Statistics

The statistics for each variable, for the time period shown, are given. Also, the east and north covariance, correlation, and vector statistics are given.

The mean values for each variable are the same as those plotted in the histograms.

For reference, note that a Gaussian random variable would have a kurtosis of 3 and a skewness of zero.

Progressive Vector Plots

Based on a one-hour averaged time series, the current vectors are placed tail-to-head so as to show the path that a perfect particle in a perfectly homogeneous fluid would have traveled. The plots are excellent for giving an idea of flow regimes and low frequency behavior. Each tenth midnight is annotated with the date.

Spectra

The horizontal kinetic energy (HKE) and (where available) the temperature are displayed as spectra.

The horizontal kinetic energy spectrum is half the sum of the spectra of the east and north components; it has the advantage of not being tied to a particular coordinate system.

The HKE and temperature spectra have units of (cm^2/sec^2) and $(m \text{ deg } C/m)^2$, respectively. The spectra are all one-sided, i.e. the area under the spectrum is equal to the variance of the original record. The plots are all log-log hence are not "variance preserving", i.e. the contributions of various frequency bands to the total variance are <u>not</u> in proportion to the displayed areas.

The spectra are all calculated from the basic series in a single piece followed by frequency band averaging across 3 frequencies.

TIMSAN, the WHOI program (Hunt, 1978) used to produce the spectra, additionally averages the spectra in increasingly large groups at the higher frequencies to prevent having to plot thousands of points. This gives few degrees of freedom (d.o.f.) at the lowest frequencies, many at the highest frequencies.

Table 1 lists all moorings set in 1973 with the WHOI reference numbers for those which have already been described in data reports. A description of techniques and materials used in the 1973 moorings, as well as in moorings of other years is given in Heinmiller (1976). Table 2 gives more detailed information on the current meter records presented in this report. Table 3 contains an evaluation of data quality for all current meter records included in this report.

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Metcalf, W. G., M. C. Stalcup and M. Zemanovic, 1977, Current meter and temperature records from the Windward Passage. Woods Hole Oceanographic Institution Technical Report 77-29

Payne, R. E., A. L. Bradshaw, J. P. Dean and K. E. Schleicher, 1976, Accuracy of temperature measurement with the VACM. Woods Hole Oceanographic Institution Technical Report 76-94.

Wunsch, C., 1975, Internal tides in the ocean. Rev. Geophys. & Space Phys., 13, 167-182.

Wunsch, C., 1976, Geographical variability of the internal wave field: a search for sources and sinks. J. Phys. Oceanogr., 6, 471-485.

Wunsch, C. and S. Webb, 1979, Climatology of the deep ocean inertial wave field. J. Phys. Oceanogr., (in press).

Table 2

Data	Depth (m)	Variables Comp. Temp.	Instr. Type	Strobes Sampling Rate (sec)	Duration Days
4901	999	C	850	23/3600	201
4902	2011	C	850	23/3600	201
4911	205	C	850	23/3600	119
4912	1019	C	850	23/3600	203
4913	2030	C	850	23/3600	203
4914	2550	C	850	23/3600	203
4922	2019	C	850	23/3600	201
5061	185	CT	850	23/3600	175
5062	988	C	850	23/3600	175
5063	1995	C	850	23/3600	175
5072	491	T	850	23/3600	169
5073	999	C	850	23/3600	176
5074	2006	C	850	23/3600	176
5081	2649	CT	VACM	900	51
5082	2653	CT	VACM	900	51
5084	2661	CT	VACM	900	51
5085	2665	T	VACM	900	51
5086	2669	CT	VACM	900	51
5087	2673	CT	VACM	900	51
5088	2677	CT	VACM	900	51
508,10	2685	CT	850	15/900	51
5091	179	C	850	23/3600	176
5092	980	C	850	23/3600	176
5093	1987	C	850	23/3600	176
5181	2140	CT	VACM	900	133
5182	3039	C	VACM	900	133
5191	2089	CT	VACM	3600	132
5192	2988	CT	VACM	3600	132
5201	2181	CT	VACM	900	42
5202	3023	CT	VACM	900	132
5203	3027	CT	VACM	900	132

Table 3

Comments on Moorings and Instruments

Mooring 490 - Set by Faking Box

4901 - Good

4902 - Good

Mooring 491 - Set by Faking Box

4911 - All variables bad July 24-29; no data recoverable after Aug. 3rd.

4912 - Good

4913 - Compass and vane have some bit problems in May and June

4914 - Good

Mooring 492 - Set by normal float first method. 59 minutes between float over and anchor over (1764 meters)

4921 - No speeds; no data presented

4922 - Good

Mooring 506

5061 - Good

5062 - Minor bit problem in compass last two months

5063 - Good

Mooring 507

5071 - No recoverable data; mechanical problems

5072 - Every other temperature word was bad. Bad values replaced by previous good value. Use data with caution as post-cruise instrument check showed non-standard components had been used.

5073 - Good

5074 - Least significant bit in vane always zero. Greatest possible error ± 3°.

Mooring 508 - All current meters separated by 2 meters of 3/8" chain and to glass spheres in hard hats. Bottom instrument 25 meters off the sea floor. Top instrument 65 meters off the sea floor, 2613 meters below the surface.

5081 - Good

5082 - Second least significant vane B.T. always zero. Greatest possible error ± 6°.

5083 - No data - mechanical problems

5084 - Good

5085 - Temperature data presented - modification to rotor circuit caused bad speed values.

Table 3 (continued)

Comments on Moorings and Instruments

5086 - Good

5087 - Good

5088 - Vane is sticky Nov. 1st to end of record

5089 - No recoverable rotor or temperature values

508,10 - Good; instrument had been miswired switching polarity. Modified computer program recovered data.

Mooring 509

5091 - Unusually strong event March 14th

5092 - Good

5093 - Good

Mooring 517

5171 - Corrosion module

5172 - Good

5173 - No temperature data

Mooring 518

5181 - Good

5182 - No temperature data - vane sticky after March 3rd. Time error greater than 1 recording cycle (15 minutes).

Mooring 519

5191 - Good

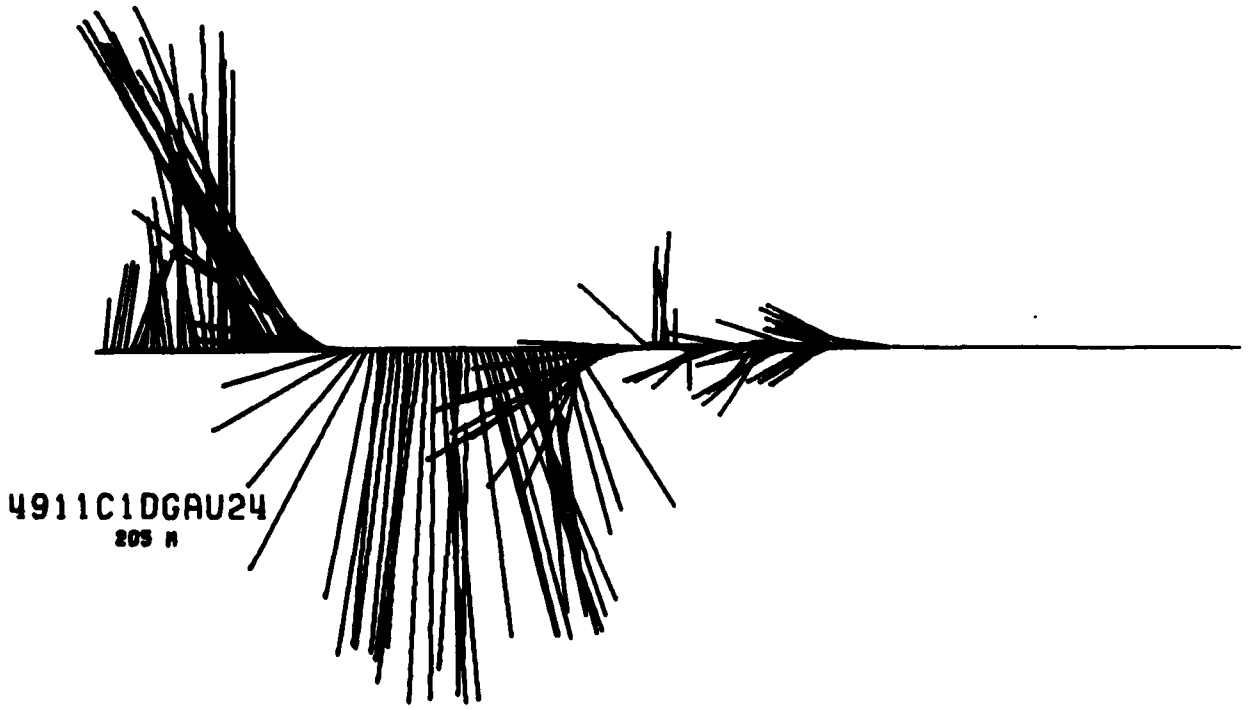
5192 - Good

Mooring 520

5201 - Vane progressively sticky from Jan. 23rd to Feb. 7th. Stuck Feb. 7th to end April 23.

5202 - Good

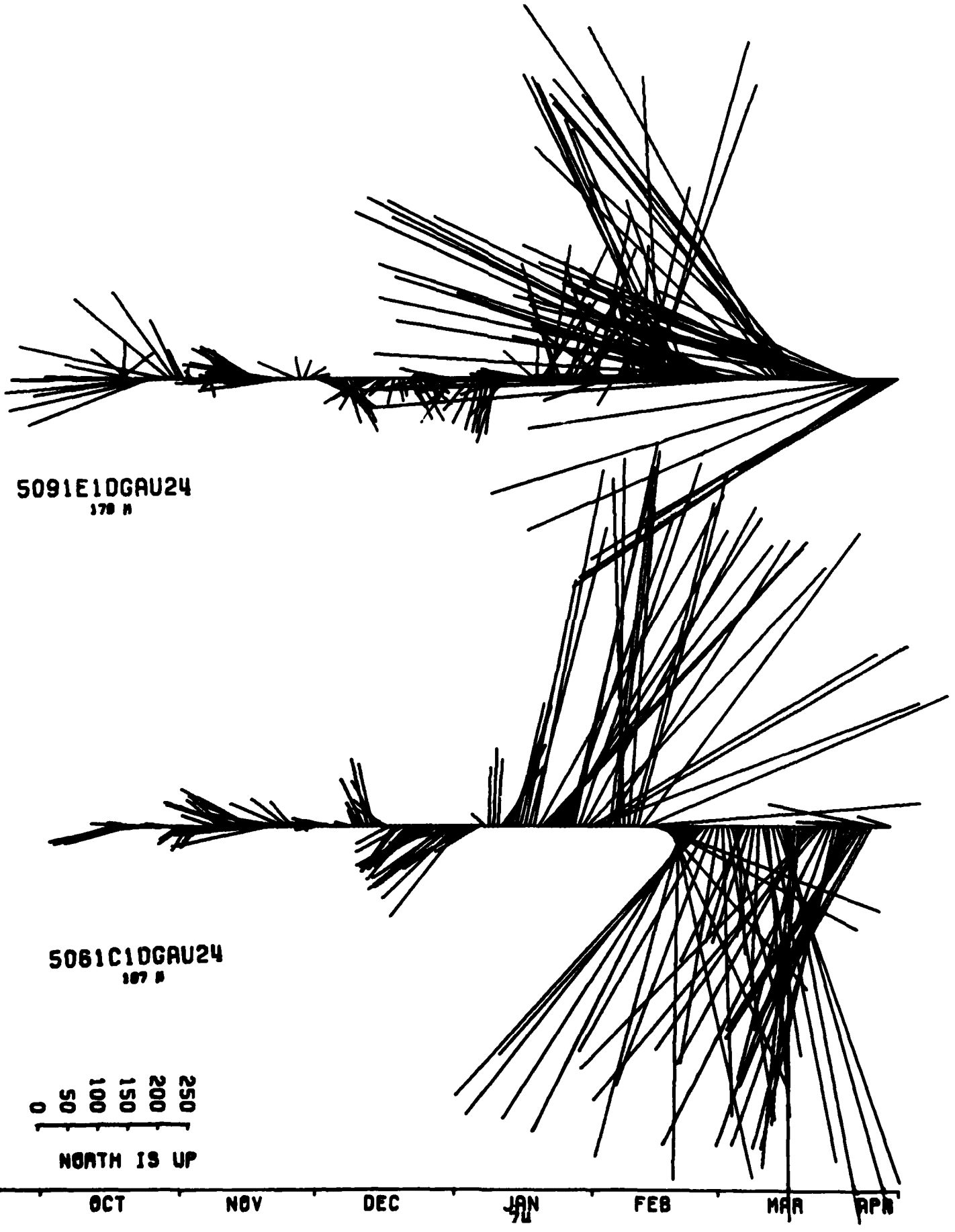
5203 - Temperature resolution is good. However the absolute values are uncertain as it is not known which thermistor was used in this instrument.



NORTH

0 (MM/SEC) 250

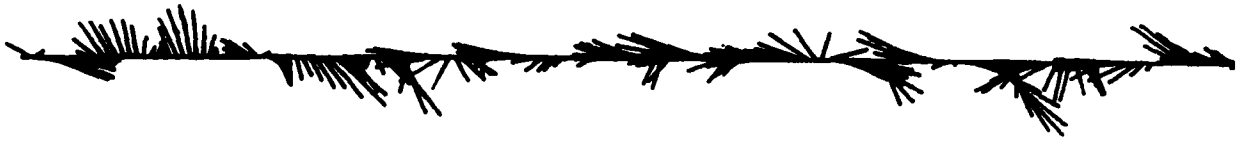
APR 73 MAY JUN JUL AUG SEP


5091E1DGAU24
178 M
5061C1DGAU24
187 M
0
50
100
150
200
250
NORTH IS UP
OCT
NOV
DEC
JAN
FEB
MAR
APR

APR 73 MAY JUN JUL AUG SEP

NORTH

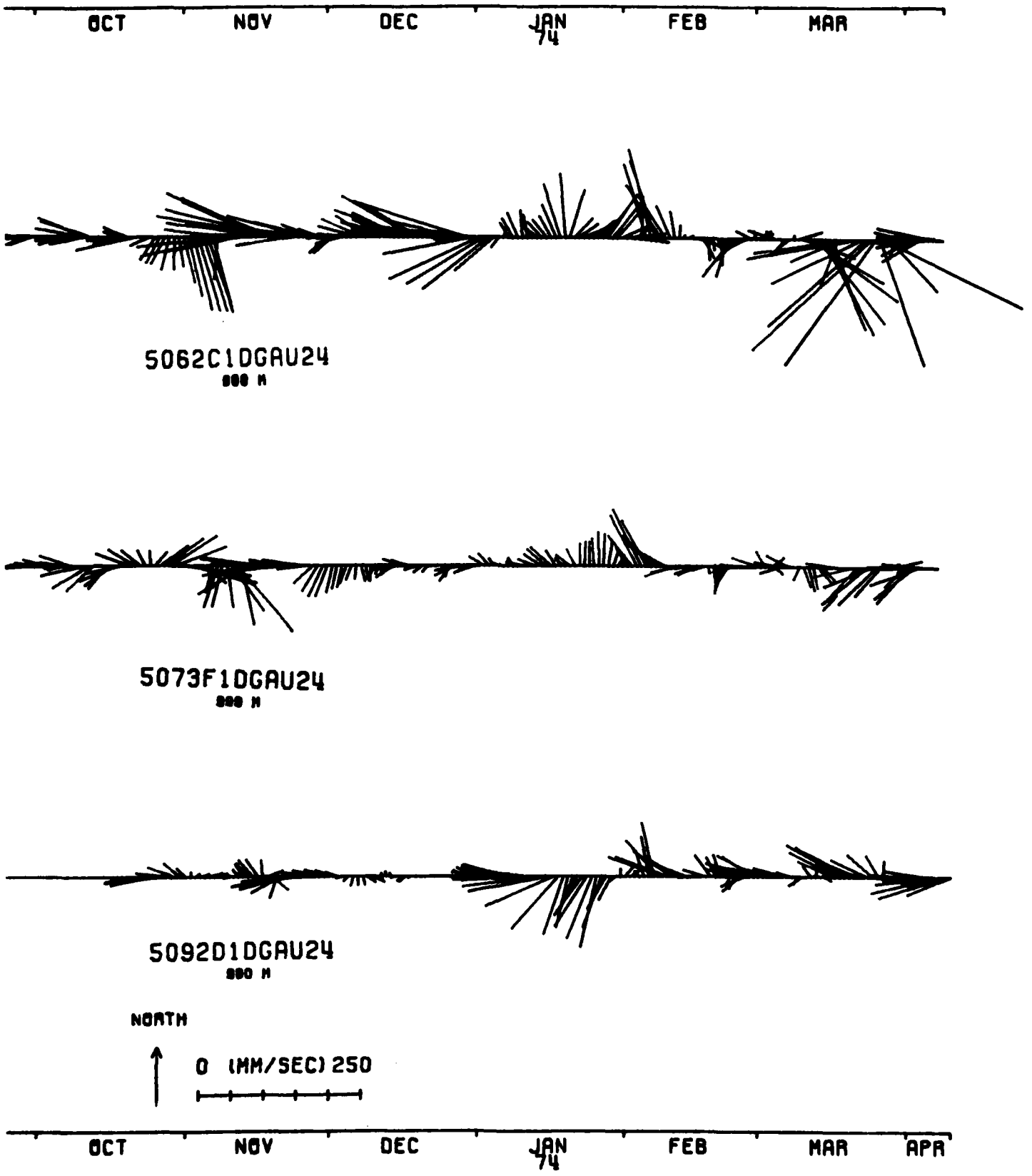
0 (MM/SEC) 250

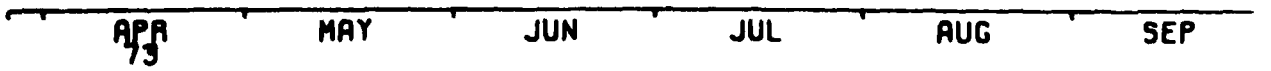


4901B1DGAU24
900 M

4912B1DGAU24
1010 M

APR 73 MAY JUN JUL AUG SEP


OCT
NOV
DEC
JAN
74
FEB
MAR
5062C1DGAU24
5073F1DGAU24
5092D1DGAU24
NORTH
0 (MM/SEC) 250
OCT
NOV
DEC
JAN
74
FEB
MAR
APR

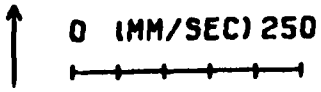


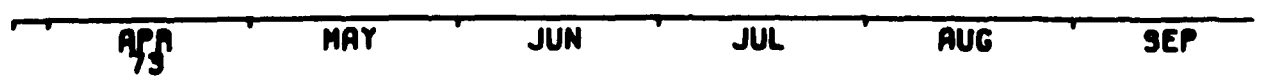
4902B1DGAU24
2011 M

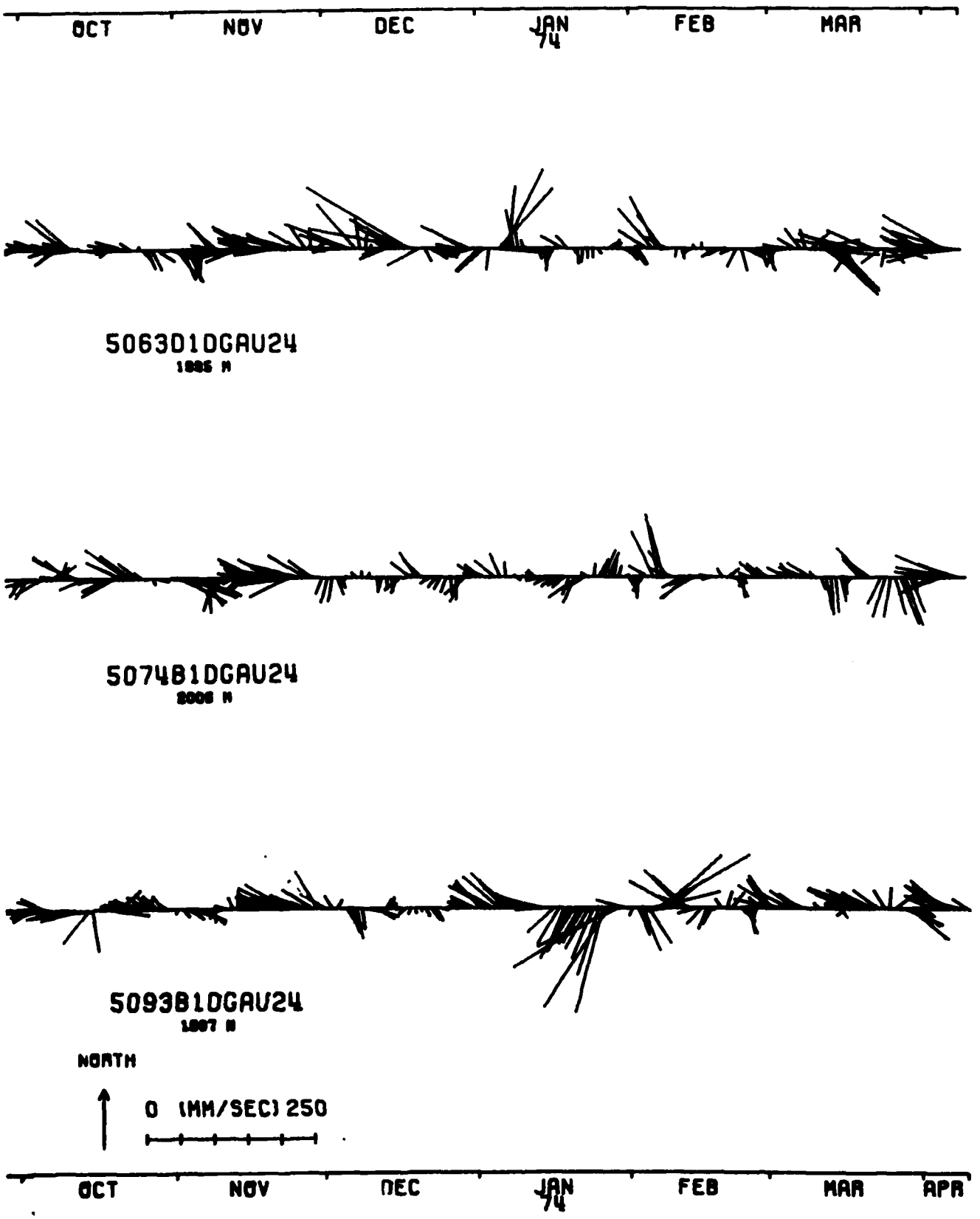
4913C1DGAU24
2030 M

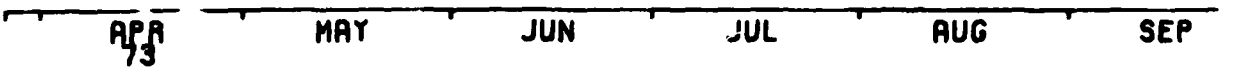
4922B1DGAU24
2018 M

NORTH

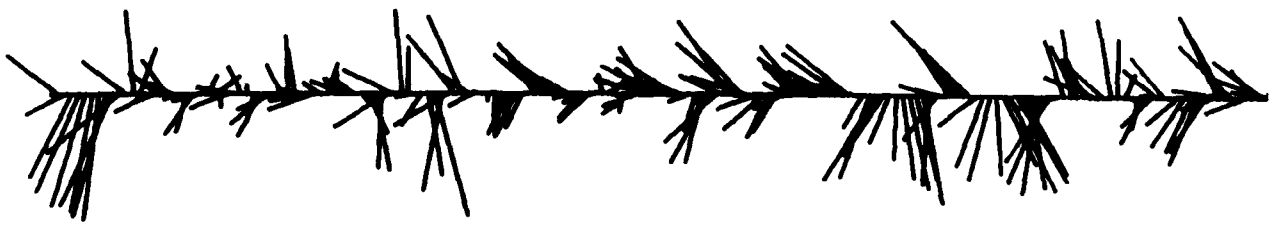




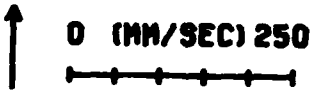

OCT
NOV
DEC
JAN
74
FEB
MAR
5063D1DGAU24
1985 M
5074B1DGAU24
2006 M
5093B1DGAU24
1997 M
NORTH
0 (MM/SEC) 250
OCT
NOV
DEC
JAN
74
FEB
MAR
APR



4914B1DGAU24
2550 M



NORTH



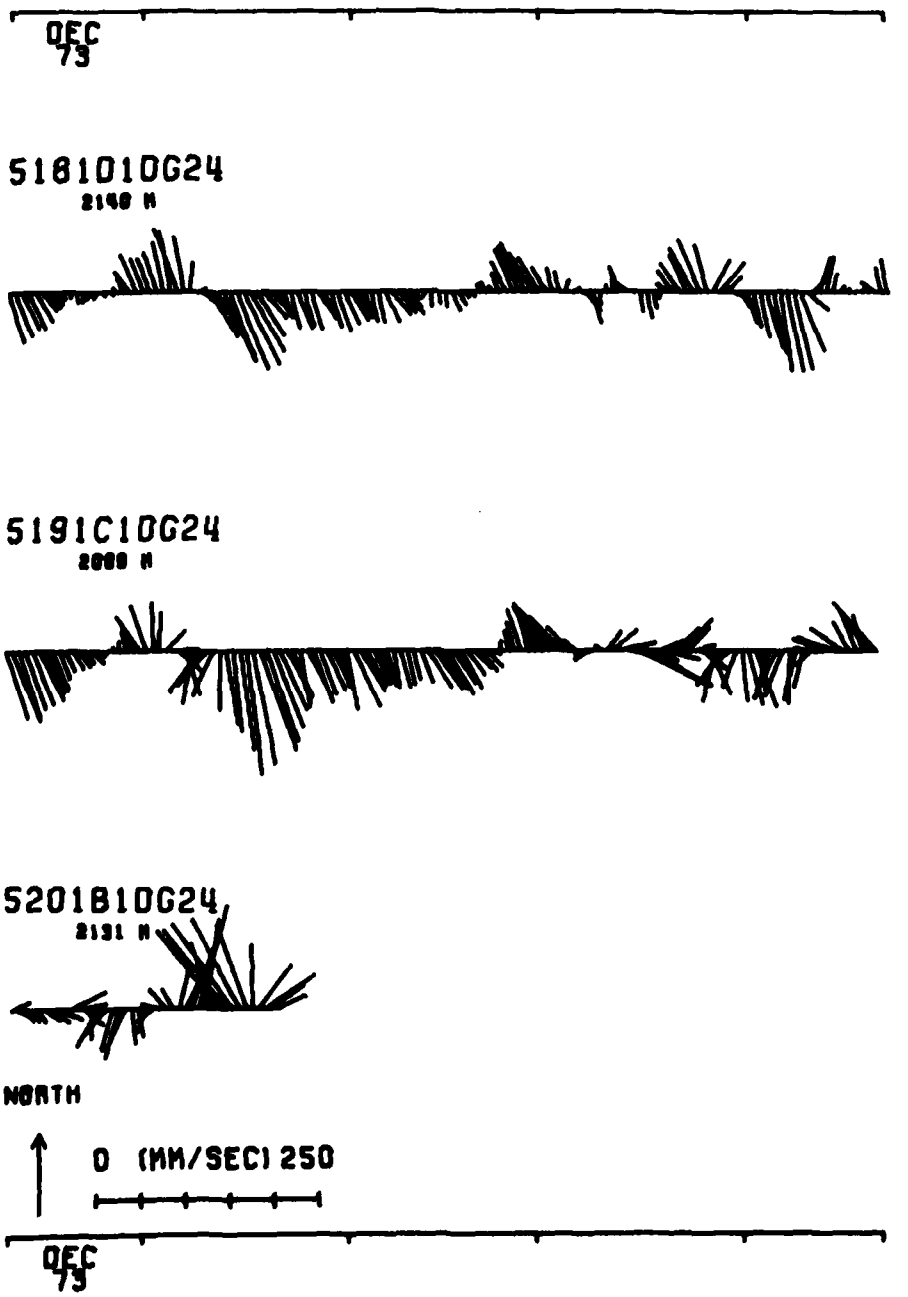
OCT NOV DEC JAN 74 FEB MAR

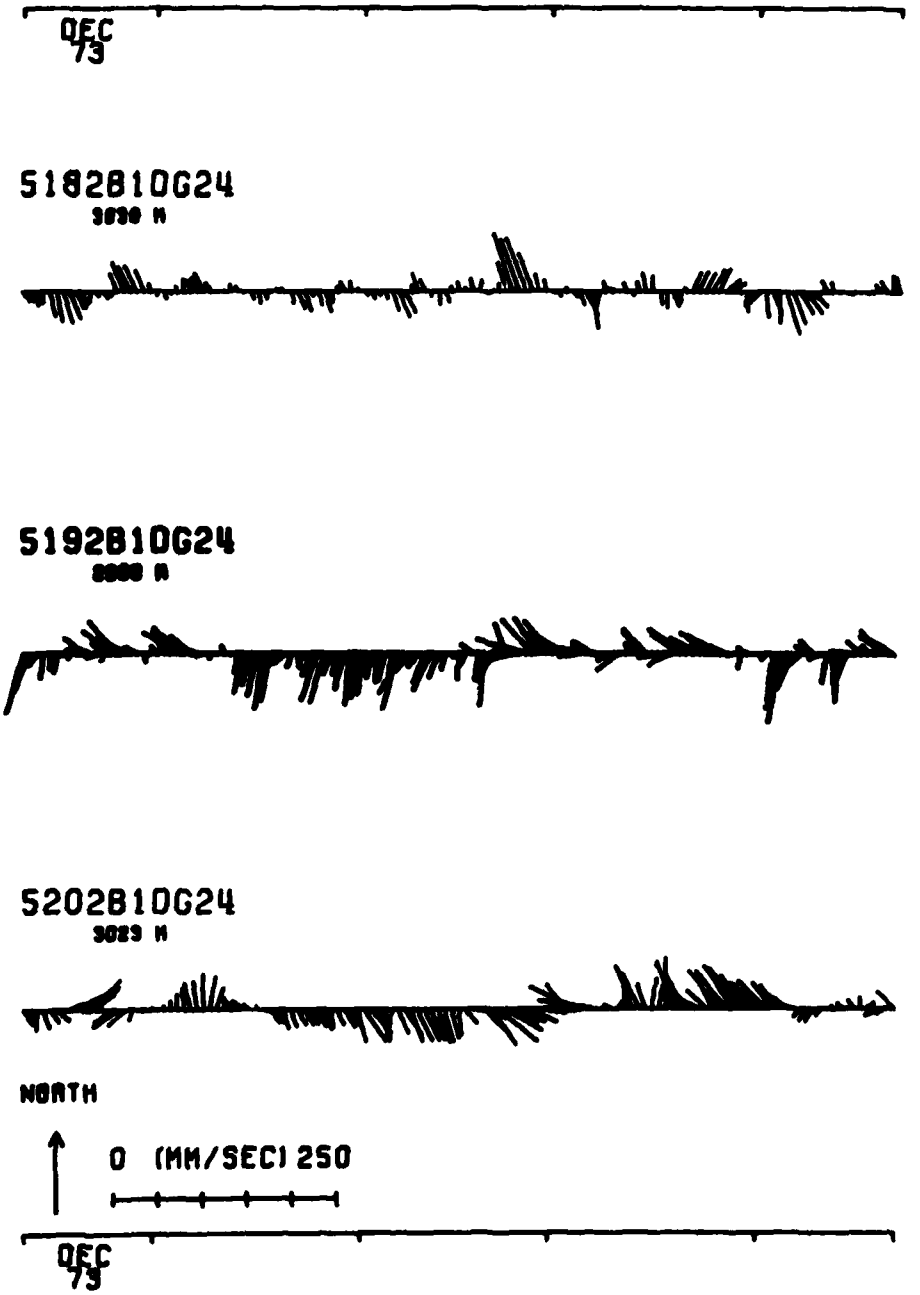
5081B1DGAU24

NORTH

0 (MM/SEC) 250

OCT NOV DEC JAN 74 FEB MAR


OEC
73
5181D1DG24
2140 M
5191C1DG24
2000 M
5201B1DG24
2131 M
NORTH
0 (MM/SEC) 250
OEC
73


DEC
73
5182810G24
3030 M
5192810G24
3000 M
5202810G24
3029 M
NORTH
0 (MM/SEC) 250
DEC
73

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Current and temperature measurements from instruments on moorings set in 1973 at Site D and the Muir Seamount are presented. Both horizontal and vertical arrays are presented using low-passed filtered data. The basic time series from individual current meters are displayed with statistical tables, spectral diagrams, progressive vector plots, and plots of variables versus time.

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3. Temperature

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